PART II.

BAMBOOS, THEIR MODE OF GROWTH AND THE POSSIBLE OUTTURN.

1. Species of bamboos.

Bambusa arundinacea—the Daugi bamboo of Kanara—occurs throughout the Peninsula and is found at its best in the moist forests of the Western Ghats. In the latter locality it grows to a great size, often being found 100 ft. in height and each culm of great weight. A peculiar feature of this species is that it forms a dense palisade of small armed lateral branches round the base of the clump. This palisade reaches often 6 to 8 ft. upwards from the ground and makes extraction, looking to the weight and size of the culms, an expensive and difficult matter. Another drawback to this species is the thickness of the stem-walls and the hardness and size of the nodes. On the other hand, the local wood-cutters, who are used to dealing with this class of bamboo, are quite capable of carrying out its extraction, and though the cost of doing so is relatively high per culm, their great weight compensates for the extra expenditure, so that the actual cost of collecting one ton of dry bamboo works out to about the same as that of the lighter and more easily handled species found in Burma.

Bambusa polymorpha—the Kyathaung bamboo of Burma—is one of the commonest species found in the Pegu Yomas. The culms grow to nearly as large a size as those of *Bambusa arundinacea*. They are, however, unarmed, and do not grow in so compact a mass, besides which, owing to their relatively thin walls and small nodes, they are much more easily handled. They have therefore, in all points, the advantage over the larger species, when considered in connection with the pulp industry, except that they do not yield the same quantity of raw material per culm.

Cephalostachyum pergracile—the Tinwa bamboo—is also a Burma species, found in both the Upper and Lower provinces. In the Pegu Yomas it is very plentiful, but not quite so common as *Bambusa polymorpha*. It is smaller in size than that bamboo, but, in other respects,

as far as the paper industry is concerned, it is quite as suitable for pulp as that species.

Melocanna bambusoides—the Wanwé bamboo of Arakan, Burma and Assam—is found throughout Arakan, the Surma and Assam Valleys and Chittagong. It has an entirely different habit to those above mentioned in that, instead of growing in clumps, it emerges from the ground at short intervals, each stem being at a considerable distance from the next. It is a small, unarmed, soft bamboo, rarely over 30 ft. to 50 ft. in height, weighing from 3 lbs. to 10 lbs. when dry, with thin walls and small nodes. A full description of its mode of growth is given in Part IV of this report.

2. Bamboo as a fibre-yielding plant.

Bamboos come under the Natural Order *Gramineae*, to which order also belong the grasses. The fibres formed by the vascular bundles are extremely silky and fine and if seen under a microscope show fine barbs, an important factor in the "felting" and strength of pulp made of this material. The fibres in the internodes are arranged in regular parallel lines, with no tendency to be twisted or contorted, as is the case in certain species of timber, so that they can not only be split with great ease, but also be cut up into very regular sections. Another important point is that owing to the regular arrangement of the fibres and to the bamboo being hollow, the fibre can easily be reduced by crushing to a substance not unlike tow, an alternative method of treatment to cutting the bamboos before boiling which has been proposed by Raitt. That bamboos lend themselves to either of these methods of treatment is an important consideration in obtaining uniform digestion while boiling.

The suitability of bamboo fibre for the preparation of paper-pulp has been already fully demonstrated in former years by experiments carried out on a laboratory scale by various experts. The question of the quality and grade of paper produced by the various species of bamboos is fully discussed in Part III of this report.

3. Mode of growth of bamboos.

Mode of growth of Bamboos.—In order to determine the best methods of cropping bamboos in order to obtain the largest sustained yield, it is necessary to know something about the mode of growth of the various species. It might be said with justice that this information is out of

place in such a report, were it not for the fact that there appears to be doubt, in the mind of those interested, as to whether bamboo clumpa will stand repeated cutting.

Briefly, the mode of growth is as follows. The seed on germinating sends out a small shoot in the rains, completing its full growth in two or three months. This shoot may be of the thickness of a piece of straw and from 6 inches to 2 feet high. Next rains it puts out one or more shoots slightly larger both in height and diameter than the original shoot. Then, according to the species, it either again puts out more small shoots, generally speaking larger than those of the previous year, or puts out one or two distinct stems (culms) of several feet in height, and of an inch or more in girth. After that, given a normal monsoon, each year's culms tend to increase in height and diameter until the plant reaches maturity, by which time the culms put out each year have reached their maximum size. On the flowering of the bamboo the whole clump dies and new plants spring up from the seed. (A few species are an exception to this rule such as *Bambusa lineata* and *Ochlandra stridula.*)

The various cycles at which the different species flower will be dealt with hereafter. When the mature clump puts out a new culm during the rainy season, the diameter of the culm rising from the ground is the same as that when it reaches its full length; in other words, it does not increase in girth while putting on its height-growth. It grows extremely quickly attaining its full height in a few weeks or at the most during the monsoon months.

Size of culms.—The number of culms put out by a clump varies according to its age and size and also with the species. A large vigorous clump of Kyathaung (*Bambusa polymorpha*) may put out as many as 20 new culms a year. The amount of storage material which the rhizomes or root-stock of the clump has accumulated during the period of rest is fixed so that if the clump puts out an abnormal number of culms in any one year their size will be affected and they will be little, if any, longer or of greater girth than the previous year's shoots. On the other hand, if relatively few shoots are put out and the reserve material for their growth is sufficient, the size of the new shoots may be larger than the stems of the previous year. Again, if a number of bamboo clumps are inspected, there will be found here and there abortive shoots which have never reached maturity or attained their full height. Such abnormal growth is due to the root-stock having failed to supply sufficient nourishment to the culm to enable it to attain maturity.

Number of culms put out by a clump.—The actual number of culms put out by each clump, as was stated before, varies according to the size and age of the clump. In order to fix the rotation on which it is best to cut bamboos, it is necessary to know how many stems are put out, on the average, each year, by different species. With this object in view differentiation was made between under-one-year old and over-one-year old culms, when counting bamboo sample plots on the West Coast and in Burma.

By a culm under-one-year old is understood a culm which has not gone through two monsoons. By an over-one-year old culm is understood a stem which came into existence during one monsoon and which has passed through a second rainy season.

The prevailing species of bamboo on the West Coast is *Bambusa arundinacea*. Of this species the number of new stems counted was 2,675 against 9,160 old ones or in the proportion of one new stem to every 3·42 old ones.

In the Pegu Yomas, in Lower Burma, two of the commonest species are Tinwa (*Cephalostachyum pergracile*) and Kyathaung (*Bambusa polymorpha*). Of the former, 4,047 new culms were counted in the sample plots against 11,870 old ones or in the proportion of one new culm to every 2·93 old ones. Of the latter, 4,881 new culms were counted against 20,633 old ones, or in proportion of one new culm to 4·22 old ones.

The question of the proportion of new to old culms will again be dealt with when the rotation, on which the felling cycle for bamboos should be fixed, comes under discussion.

It has been explained above that the number of new culms put out per clump depends on the size and strength of the clump during any given period of its life. In order to collect definite data on this point Mr. Buchanan, a Forest Officer in Upper Burma, carried out careful countings in two successive years in sample plots chosen by him in average bamboo forest. The following table gives the results of his experiments :—

Experiments carried out in bamboo forests by Mr. E. M. Buchanan, Extra-Deputy Conservator of Forests, Myitkyina Division, Burma, in order to ascertain the number of new culms put out annually by various species of bamboos, and the yield of dry internodes per acre.

Date of counting.	Sample plot.	Species.	Number of clumps counted.	Number of culms counted.		Number of experimental culms cut.	Average length and mid-girth.		Total weight, in lbs.		Weight of nodes, in lbs.	Weight of dry internodes, in lbs.	Yield of dry internodes per acre, in lbs.	Remarks.
				Old.	New.		length.	girth.	green.	dry.				
Countings on 2nd November 1910.	A. One acre .	*Dendrocalamus Hamiltonii* (Wabom-yetsangye).	107	1,162	174	50	39′-6″	7·2″	1,402·5	..	..	..	..	Mr. Buchanan states that neither the clumps of *Cephalostachyum pergracile* nor *Bambusa pallida* are as yet mature, while those of *Dendrocalamus Hamiltonii* he classes as middle-aged.
	B. One acre .	*Cephalostachyum pergracile* (Tinwa) .	448	2,993	338	50	42′-1″	6·6″	1,383·5	640·02	66·97	573·05	..	
	C. One acre .	*Ditto ditto* . .	387	2,938	535	50	39′-9″	6·5″	1,202·5	663·57	64·97	598·60	..	
		Average per acre of sample plots B and C.	417·5	2,965·5	436·5	50	40′-11″	6·5″	1,293·0	651·79	65·97	585·82	39,871 or 18·77 tons	
	D. One acre .	*Bambusa pallida* (Samidu-Wa) . .	1,112	5,411	282	100	39′-11″	6·2″	2,036·7	1,055·4	113·7	..	..	
Countings on 23rd September 1911.	A. One acre .	*Dendrocalamus Hamiltonii* . .	..	..	*47	..	..	..	..	..	..	..	..	*These are the number of new culms put out during the rains of 1911.
	B. One acre .	*Cephalostachyum pergracile* . . .	..	..	*442	..	..	..	..	..	..	..	..	
	C.	*Ditto ditto* . . .	..	..	*384	..	..	..	..	..	..	..	..	
				Average .	413	..	..	..	..	..	..	..	..	
	D. One acre .	*Bambusa pallida*	..	..	*293	..	..	..	..	..	..	..	..	

NOTE.—He proposes to carry out further experiments by thinning the clumps, in order to ascertain the effect of cutting out mature culms on the growth of new shoots. The results of these experiments, when completed can be communicated, to any interested persons who care to make enquiries of the Forest Economist at Dehra Dun.

We are here chiefly concerned with the second species given in the above table, namely, *Cephalostachyum pergracile*, or Tinwa bamboos. The countings made in 1910 showed the two sample plots to contain an average of 417 clumps per acre, containing 2,965 old and 435 new culms, or a total of 8·1 culms per clump. It was found that 413 new shoots were put out by these clumps during the rains of 1911, that is 8·1 old culms were capable of producing, as nearly as possible, one new culm in one year. In Lower Burma countings made by the writer of the report (see Appendix I) gave one new culm to every 2·93 old ones, or roughly one new to every three old culms. The difference between the two results obtained is very marked, but nevertheless agrees in every respect with the mode of growth of bamboos. In the second paragraph of this section it has been explained how the culms and clumps as a whole increase in size, namely, that both the size of the stem produced and the number of culms put out in any given year depend on the power of the root-stock to store up nourishment against the period during which it has to produce new shoots.

Now the Tinwa bamboo clumps counted in Myitkyina Division by Mr. Buchanan were stated by him to be immature, while those counted in Lower Burma were somewhat over middle age, in other words, the root-stocks of the Myitkyina bamboos had not attained the same power of accumulating nourishment as had those in the areas inspected in Lower Burma and hence the difference in their relative power of producing new shoots every year.

In the foregoing paragraph, nothing has been said about the variation in climate in the two localities though, both areas, in which the countings were made, are typical bamboo areas for Upper and Lower Burma respectively. Without doubt the local conditions affect the growth of bamboos, so that the warm, damp, moist climate in Lower Burma no doubt partly accounts for the more favourable growth of *Cephalostachyum pergracile* in that locality.

4. Effect of cutting bamboos on the growth of the clump.

Effect of cutting stems on the growth of the clump.—The general impression arrived at after inspecting many areas in which fellings of bamboos have been carried on for many years, is that, in cases where a clump has been heavily cut over, the number of new stems put out is reduced according to the intensity of cutting, but that ultimately the

clump recovers, if given even only a short period of rest. And this is as might be expected, for the amount of nourishment which a clump can accumulate is governed by the leaf-area, so that when the leaf-area is reduced by felling a certain number of culms, the number of new shoots put out in the next season is correspondingly reduced. Another factor, however, comes into play when the vitality of a plant is reduced by cutting or pruning and that is that the plant struggles to regain its former normal state, so that with bamboos, which have enormous vitality, the deficiency is made up in a surprisingly short period of time.

Experiments on the cutting back of bamboos.—As a proof of the above assertion, there are to hand the records of experiments made some years ago in Burma, in connection with the extermination of bamboos to favour the growth of seedling teak.

The following is an extract from a letter on this subject from Mr. Muriel, Conservator of Forests, Pegu Circle, to the Chief Conservator of Forests, Burma :—

> "Experiments were made in the Tharrawaddy Division (new Zigôn and Tharrawaddy) from 1892 to 1897 to see if the cutting of the shoots of the year would cause the bamboo clumps to die * * *. An area of about 90 acres in the Kon Bilin Reserve of almost pure Kyathaung (*Bambusa polymorpha*) was operated over * * * An area of about 12 acres in the Bawbin Reserve of Kyathaung and Tinwa bamboo (*Cephalostachyum pergracile*) was similarly operated over * * * The experiment, as in the case of the Kon Bilin, being merely to determine the effect on the vitality of the bamboo clumps by cutting the annual shoots and *in both cases the experiment failed to have any appreciable effect on the vitality of the clumps.*"

In the above instance only the new shoots appear to have been cut. There is, however, to hand another experiment which was carried out in the Yaw Division, a copy of the report on which was sent by Mr. E. S. Carr, Conservator of Forests, to the Chief Conservator of Forests of Burma. The following extract is from the report by the Divisional Forest Officer, Yaw Division :—

> This work was incidental with the clearing of other undergrowth carried out in connection with an experiment, the

object of which was to determine the effect of cutting back bamboos over teak saplings (experimental plots Nos. 1 and 2, Lema, Gangaw Sub-division)."

"The following is taken from the Experimental Journal:—

March 1904. Forest Growth.

In both plots Myinwa (*Dendrocalamus strictus*) is plentiful occurring in clumps of about 20 to 40 stems and averaging 40 ft. in height.

Cultural operations.—Plot 1, practically cleared of bamboos and undergrowth."

"1904-05. Again completely cleared of undergrowth and bamboos."

"1905-06. *Inspection Notes.*—The effect of cutting back the bamboos has been to weaken it and out of each clump about one stem of 15 ft. high has been sent up.

"1906-07. *Inspection Notes.*—It is of interest that fresh culms arising from the old cut back clumps numbered from 4 to 5 stems per clump, as the result of two years' growth. They have been cut back again to facilitate getting about the area."

"1907-08. *Inspection Notes.*—It might be observed that most of this year's bamboo shoots in Plot 1, from the old stumps, have flowered."

"1908-09. *Inspection Notes.*—In Plot 1 the bamboo clumps cut down again have sent up one or two culms."

From the above records it is clear that even under the most drastic treatment, when the clumps are completely felled, several times in succession the old stock gradually recovers, and that it is practically impossible to completely destroy the plant in this way. It must, however, be recognised that the plant is weakened by over-felling and that to insure a sustained yield it must be given a period of rest between each successive felling.

5. Flowering of bamboos.

Flowering of bamboos.—The flowering of bamboos is a very complicated subject. The late Sir Dietrich Brandis, one of the greatest

experts on bamboos, divides them up into three classes when dealing with this question. The first group seeds yearly or nearly so and dies after flowering. With the species included in this group we are not concerned. The second he describes as flowering gregariously and periodically, all culms of one clump and all clumps in one district flowering simultaneously. He adds, however, that in different districts they flower at different times. In this case the culms die after ripening their seed, and usually the under-ground rhizomes also die. To this class belong *Bambusa polymorpha* (Kyathaung) and *Bambusa arundinacea*, two species with which we are closely concerned in the paper-pulp business. The third group contains irregularly flowering species, amongst which come *Cephalostachyum pergracile* (Tinwa).

Definite data as to the intervals at which the different species of bamboos flower are not yet available. Brandis states that *Bambusa polymorpha* flowers at long intervals, he records it as flowering in different localities in Burma in 1854, 1859, 1860, 1862 and 1871. Since then no general flowering has been recorded. *Bambusa arundinacea* of the West Coast and Peninsula is said to flower every 30 to 32 years, while *Cephalostachyum pergracile* (Tinwa) belongs to the third class, and is said by Brandis to flower frequently, at times gregariously over large areas. While on inspection in the Toungoo Division, an area of Tinwa which flowered in 1904 was seen; many of the old dead culms were standing over a dense crop of young plants, six years after the flowering had taken place, and these old culms, though dry, appeared still suitable for pulping. *Melocanna bambusoides*, the last species with which we are concerned, flowers at long intervals. Brandis states that in Arakan it flowers every 30 to 35 years. The writer inspected certain areas which had flowered in various places in Arakan and he arrived at the conclusion that the bamboos flowered in large patches of several square miles on one hill-side, but found no instance of wholesale flowering all over one district or large catchment area.*

The question of the flowering of the bamboo and its subsequent drying is a factor that has to be seriously considered as affecting the sustained yield. There are, however, certain factors which make it possible to rely on a continued supply of raw material from the bamboo areas. The first is that generally more than one species occurs in every

*NOTE.—It is understood that *B. arundinacea* has flowered heavily in certain localities of Kanara during the rains of 1911. Since the above was written the writer has noted nearly universal flowering of *M. bambusoides* in the Cachar Division of Assam.

forest and that the chances of them all flowering at the same time are very remote; secondly, that though the flowering may take place in one catchment area, or even over a whole district, at one time, the areas covered by bamboos are so vast that raw material will always be available from other localities, though the cost of extraction may be slightly increased for a time; and again dry culms do not disappear at once, so that the period during which the new crop is coming into existence may be partly tided over by extracting the dry culms to supply the mill; and lastly both *Bambusa polymorpha*, *Bambusa arundinacea** and *Melocanna bambusoides** only flower at long intervals.

6. Felling of bamboos.

Rotation on which to cut bamboos.—Bamboos have only been cut on a fixed rotation in places where the demand exceeds the supply. This is the case in the Lansdowne Division of the United Provinces, where the rotation is fixed at two and three years according to locality. We know nothing about the rotation for cutting *Bambusa polymorpha*, *Bambusa arundinacea*, *Cephalostachyum pergracile* and *Melocanna bambusoides* with which four species we are chiefly concerned.

On page 18 under the heading "Number of culms put out each year" it was stated that the proportion of new culms to old was as follows:—

	New.		Old.
Bambusa arundinacea	1	to	3·42
Bambusa polymorpha	1	to	4·22
Cephalostachyum pergracile	1	to	2·93
Average	1	to	3·52

The ratio therefore stands at 1 to 3·52, or say, as 1 to 4. It, therefore, requires four old culms to produce one new culm. Based on these figures, it takes four years to replace the old culms, leaving arithmetical progression out of the question. Now as the outturn from the areas dealt with in this report are capable of yielding annually a far greater quantity of material than any mill is likely to require for the present, the proposed rotation on which the sustained yield is based is put for

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safety's sake at five years. From experience it may be possible to reduce the rotation of felling for certain species of bamboos.

The rotation on which *Melocanna bambusoides* can be cut is put at 7 years, this figure having been arrived at by inspecting even-aged crops of this species in the Arakan Division.

Method of executing the cutting.—As has been shown above, it is not advisable to cut all the stems in one clump, as though by so doing the clump would probably not die, such drastic treatment would weaken it considerably. It is therefore proposed that 25 per cent. of the culms should be left per clump, of which at least half be young ones, to divide the area roughly into five blocks, and to carry out the cuttings in one block each year. Such an arrangement would not be possible were the total possible yield not far in excess of what is actually required. On the other hand, by such an arrangement the supply would certainly be maintained for ever.

After the cuttings have been carried out for one rotation and the effect of doing so ascertained, it might quite likely be found possible to modify the rules in the light of further experience. In any case, the Local Governments will, from the first, frame their own rules as regard the cuttings, which will be settled when a firm or company comes forward to apply for a concession, so that the above observations are only an outline of the possible solution to the problem.

Cutting stems of different ages.—As regards cutting stems of different ages, in practice it will be difficult to do more than differentiate between those under and over one year old.

In the past while carrying out laboratory tests, the experts have made fine distinctions between culms of 1, 2, 3, 4 years and over. As above stated, this is of no value in practice, as it is certain that while cutting bamboos on a large scale it will not be possible to make the coolies differentiate further than between under-and over-one-year old culms.

The effect on the growth of a clump by cutting under-one-year old culms is still a disputed point. It is generally recognised that they should be left standing. However, in the light of the experiments carried out in the Tharrawaddy and Yaw Divisions, and after inspecting a very large number of clumps over which fellings have taken place, it appears that the harm done to the clump is not so great as it is generally supposed to be. It is therefore thought that, provided about 50 per cent. of the new shoots are spared and that the cuttings are carried out

on a five-year rotation, there will be no harm done by cutting the other 50 per cent. of the new shoots.

7. Size and weight of bamboos.

Size and weight of culms of various species.—An important point is the size and weight of the culms of various species, as on these factors depends the facility and cost of their removal from the forest to the mill. Throughout this report the calculations of weights of dry bamboos and the yield per acre are based on the assumption that the nodes cannot be treated. This has been done for safety's sake, as by so doing the possible yield in tons from a given area is reduced and the cost increased. If, however, as demonstrated by the recent tests carried out on commercial lines at the Titaghur Paper Mills with chopped bamboos and by Raitt in his laboratory experiments with crushed bamboo, the nodes can be reduced to pulp (about which there is now no doubt), the estimates of yield per acre in this report may be raised 15 per cent. for *B. arundinacea*, 10 per cent. for *B. polymorpha* and *C. pergracile*, and 7 per cent. for *M. bambusoides*, while the cost of extraction may be reduced in proportion.

The following is the average size and weight of culms of the four species here dealt with :—

Species.	No. of culms on which the figures are based.	Average weight of one green culm, in lbs.	Average weight of one dry culm, in lbs.	Weight of dry internodes yielded by one culm, in lbs.	Average length, in feet.	Average mid-girth, in inches.
Bambusa arundinacea	1,084	62·0	42·0	35·7	44·3	8·9
Bambusa polymorpha	400	35·96	Not known, as the nodes were cut out green.	20·05	43·6	9·3
Cephalostachyum pergracile.	400	15·08	Do.	9·82	33·05	6·05
Melocanna bambusoides	10,575	2·45	1·55	...	22·0	3·8

NOTE I.—The length of the culms was taken after cutting off the thin top where it was about one inch in girth, the figures being the average of culms cut in six districts of Bombay and Madras, four in Burma and one in Arakan.

NOTE II.—For full details on which the above figures are based, see Appendices I to VI.

NOTE III.—These figures are averages based on all countings made in various localities.

8. Cost of extraction.

Cost of extraction.—The cost of extraction must vary according to locality and species. In part IV of this report figures are worked out for each area dealt with; thus no general figure can be given. It will here be sufficient to summarise the various rates of cost in a table by showing the rates for each locality.

Cost of extracting bamboos in various localities in India and Burma.

Locality.	Species of bamboo.	Method of extraction.	Cost of extraction to mill, per 100 stems.	Cost of landing a ton of dry internodes at a mill.
BURMA.			*Rs. a. p.*	*Rs. a. p.*
(1) The Thonzé Reserve of the Tharrawaddy Division.	*Bambusa polymorpha.*	Floating	4 0 0	5 12 9
	Cephalostachyum pergracile	Ditto	2 8 0	7 6 0
(2) The Hlaing Yoma and Okkan Reserves of the Rangoon Division.	*Bambusa polymorpha.*	Ditto	4 0 0	5 12 9
		By road and rail.	9 8 0	10 14 0
	Cephalostachyum pergracile.	Ditto	3 0 0	8 13 7
			5 8 0	10 5 3
(3) Pyinmana Division	*Bambusa polymorpha.*	Floating	7 8 0	6 8 5
	Cephalostachyum pergracile.	Ditto	6 0 0	11 2 6
(4) The Bondaung, Kabaung, East Swa, and Saing Yané Reserves of the Toungoo Division.	*Bambusa polymorpha.*	Ditto	6 8 0	5 10 6
	Cephalostachyum pergracile.	Ditto	5 0 0	9 4 9
(5) The Seik Catchment area of the Arakan Division.	*Melocannā bambusoides.*	Ditto	1 0 0	14 11 0

Cost of extracting bamboos in various localities in India and Burma—(concld.)

Locality.	Species of bamboo.	Method of extraction.	Cost of extraction to mill, per 100 stems.	Cost of landing a ton of dry internodes at a mill.
			Rs. a. p.	*Rs. a. p.*
(6) The Kaladan and Lemru Catchment areas in Arakan.	*Melocanna bambusoides.*	Floating	1 8 0	21 12 0
BOMBAY.				
(1) The Gangavalli Catchment area in the West and East Kanara Forest Divisions.	*Bambusa arundinacea*	Ditto	11 0 0	9 14 5
		By carting	15 12 0	13 8 0
(2) The Kala Nadi Catchment area in the West and North Kanara Forest Divisions.	Ditto	Floating	10 0 0	9 0 0
(3) The Mungod Forests, of the East Kanara Forest Divisions.	Ditto	Carting to Bomanhalli;	8 7 0	8 6 0
		to Hubli.	16 6 9	13 1 0
MADRAS.				
(1) The Uppinangadi and Puttur bamboo areas in South Kanara Division.	*Bambusa arundinacea*	Carting and floating from Uppinangadi;	16 6 0	7 10 6
		ditto from Puttur.	23 12 0	11 13 0
(2) The Kanoth forest of the North Malabar Division.	Ditto	Carting	23 0 0	9 10 6
(3) The Nilambur and Amarampalam forests of the South Malabar Division.	Ditto	Floating: from Nilambur;	10 0 0	3 11 2
		ditto from Amarampalam.	15 0 0	5 8 10

NOTE.—In the event of it being found possible to pulp both nodes and internodes of any of the above species, the cost of landing one ton of dry internodes, as given in the last column, would be reduced from anything between 7 per cent. and 15 per cent. according to species.

The figures in the above table show variations from between Rs. 3 to Rs. 12 and in the case of the Kaladan and Lemru catchment areas Rs. 22 in the cost of extraction of one ton of dry internodes, and this is as might be expected, considering the varying conditions met with in the various provinces. The average is about Rs. 9 per ton for dry internodes and this figure is well within the economic limit of working, which is about Rs. 15 per ton.

A point which requires explanation is the relative cost of exploiting 100 bamboos as compared with the cost of landing one ton of dry internodes at the mill. Take, for instance, the Kanoth forests in Madras. It costs Rs. 23 to land 100 bamboos at the mill, while it only costs Rs. 9-10-6 to land a ton of dry internodes from the forest to that place. The reason for this is the enormous size to which the bamboos grow in that locality and therefore relatively few bamboos are required to make a ton of the raw material. The case is exactly the reverse in the Thonzé reserve of the Tharrawaddy Division, where 100 *Cephalostachyum pergracile* cost Rs. 2-8-0 only, but on account of their lightness it costs Rs. 7-6-0 to land a ton of dry internodes at the mill.

It is here of interest to note the figures of cost arrived at by Sindall in his report. In paragraph 31, page 13, of the report he writes: "Cost of bamboos for the manufacture of pulp, with bamboo costing Rs. 9-8-0 per ton, the value of the raw materials required for a ton of unbleached pulp works out at a reasonable figure."

From the above table of figures, which have been based on careful weighings of many stems, and on enquiries into the local conditions, the figure arrived at is generally lower than that quoted by Sindall; nevertheless, they correspond sufficiently closely to corrroborate that gentleman's estimates.

9. Outturn.

The outturn from any given locality must necessarily depend on the size of the area from which bamboos can be exploited and the size and density of the crop.

Valuation surveys in bamboo areas.—One of the most arduous portions of this enquiry has consisted in taking a very large number of sample plots and linear valuation surveys in the various areas which were inspected. In making these valuation surveys, after the sample plot had been laid out on the ground, every clump was counted within the area and every stem counted in each clump. In many cases the number of

stems was counted twice over so as to prevent any mistake being made. Further, while counting the number of stems in a clump, separate records were kept of the number of new and old culms. Another point kept in view was to always pick out areas where the growth of the bamboo was normal or slightly under normal. The results of these countings are given in detail in Appendices I to V.

Possible outturn from various localities.—These enumerations were made together with the weighings of green and dry culms, in order to ascertain the average yield per acre of dry internodes, so as to arrive at an estimate of the possible annual outturn of raw material in any given area. In the following table is given a résumé of the possible outturn for the various localities, which are described in detail in Part IV of this report:—

Locality.	Area from which bamboos can be exploited, in acres.	Species.	Approximate yield per acre, in tons.	Approximate annual sustained yield, working on a 5-year rotation, in tons.
BURMA.				
(1) The Thonzé Reserve of the Tharrawaddy Division.	40,037	*Bambusa polymorpha* and *Cephalostachyum pergracile.*	7·8	62,417
(2) The Hlaing Yoma and Okkan Reserves of the Rangoon Division.	86,700	Ditto	7·8	135,305
(3) Pyinmana Division.	271,372	Ditto	17·6	955,029
(4) The Kabaung, Bondaung, East Swa and Saing Yané Reserves of the Toungoo Division.	74,570	Ditto	17·6	261,842
(5) The Seik Catchment area of the Arakan Division.	57,600	*Melocanna bambusoides.*	7·1	58,423*

*NOTE I.—Calculated on a 7-year rotation against 5 years for the other areas.

Locality.	Area from which bamboos can be exploited, in acres.	Species.	Approximate yield per acre, in tons.	Approximate annual sustained yield, working on a 5-year rotation, in tons.
BOMBAY.				
(1) The Gangavalli Catchment area in the West and East Kanara Forest Divisions.	1st class area 38,643 2nd class area 30,080 68,723	*Bambusa arundinacea.*	1st class area 5·3 2nd class area 0·88	40,321
(2) The Kala Nadi Catchment area in the West and North Kanara Forest Divisions.	Valley forests 20,374 Gund forests 7,000 27,374	Ditto	Valley forests, 1st class, 5·3 2nd class 0·88 Gund forests 12·9	32,107
(3) The Mungod forests of the East Kanara Forest Divisions.	113,000	Ditto	2·2	55,028
MADRAS.				
(1) The Uppinangadi and Puttur forest of the South Kanara Division.	35,798	Ditto	2·9	17,051
(2) The Kanoth bamboo area of the North Malabar Division.	3,000	Ditto	13·2	7,980
(3) The Nilambur and Amarampalam bamboo areas of the South Malabar Division.	9,280	Ditto	10·9	17,676